Utah Department of Environmental Quality
Division of Water Quality
TMDL Section

East Canyon Creek TMDL

Waterbody ID	**East Canyon Creek**
Hydrologic Unit Code	16020102
Location	Summit & Morgan Counties, Northern Utah
Pollutants of Concern	Total Phosphorus Dissolved Oxygen
Impaired Beneficial Uses	Class 3A: Protected for cold water species of game fish and other cold water aquatic life
Average Concentrations of Total Phosphorus (Aug. - Sept.) **Current Concentration** **TMDL Target Concentration** **Concentration Reduction**	 Above Res. 0.12 mg/l Above Res. 0.05 mg/l .07 mg/l (58% reduction)
Defined Targets/Endpoints	- 0.04 mg/l Total Phosphorus in stream concentration above the WWTP - .05 mg/l Total phosphorus concentration in stream below WWTP. - Dissolved Oxygen at or above Utah Standards - Macrophyte Growth limited to less than 50% - Periphyton (to be developed)
Implementation Strategy	WWTP Plant Upgrade and nonpoint source BMP's

Total Maximum Daily Load
for
East Canyon Creek

Utah Department of Environmental Quality
Division of Water Quality

Final April 1, 2000

INTRODUCTION

The upper East Canyon watershed is located in north central Utah approximately 20 miles east of Salt Lake City (see fig. 2). The watershed drains 144 square miles of mountainous terrain on the eastern slope of the Wasatch Mountains. The elevation of the watershed ranges from over 10,000 feet in the southern end to approximately 5,600 feet at the reservoir. East Canyon Creek is the principal drainage flowing to the north into the East Canyon Reservoir. The principal drainage channel of the upper part of the watershed in the area of Park City is made up of McLeod Creek which turns into Kimball Creek and subsequently joins East Canyon Creek near the intersection of Interstate 80 and Kimball Creek.

Climate & Streamflow - Average annual precipitation in the watershed ranges from 44 inches in the southern highest elevations to approximately 19 inches in the lower portion of the watershed adjacent to the reservoir (Brooks and others 1998). Approximately 65 to 75% of the annual precipitation occurs during the winter months principally in the form of snow. Streamflows generally peak during the snow melt between March and June. Summer stream flows are mostly derived from ground water discharges.

Water Quality Impairments - The East Canyon Creek from the East Canyon Reservoir to the headwaters is listed on Utah's 1998 303d list of impaired water bodies. The specific pollutants or stressors are total phosphorus and dissolved oxygen. This segment of the creek has been on the 303d list since1992 for the same reasons. This waterbody is included in the "high priority" group for Utah's impaired waters in the 1998 list and thus requires a Total Maximum Daily Load (TMDL) plan to restore beneficial uses and water quality standards.

Portions of this watershed are undergoing explosive growth and development over the last decade. The population has increase over 52% from 1980 to 1990 (Brooks 1998). Growth from 1990 to present appears to be at even a greater rate, particularly in light of preparations for the 2002 winter Olympics. Park City will host several venues for these Olympic games.

Statement of Intent - This TMDL will address the water quality impairments for the East Canyon Creek for dissolved oxygen and total phosphorus and is submitted to the Environmental Protection Agency in accord with the requirements of section 303d(1) of the Clean Water Act.

WATER QUALITY STANDARDS & IMPAIRMENTS

The Utah Division of Water Quality (DWQ) has classified significant waterbodies in Utah in order to assure protection of beneficial uses as follows:

Table 1: Utah Water Quality Classifications/Beneficial Uses

Class 1	Class 1C: Protected for uses as a raw water source for domestic water systems
Class 2	Recreational and Aesthetic Use
	Class 2A: Protected for primary contact recreation such as swimming.
	Class 2B: Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3	Protected for use by aquatic wildlife.
	Class 3A: Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3B: Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3C: Protected for non- game fish and other aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3D: Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
	Class 3E: Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
Class 4	Protected for agricultural uses including irrigation of crops and stock watering.
Class 5	The Great Salt Lake. Protected for primary and secondary contact recreation, aquatic wildlife, and mineral extraction.

East Canyon Creek has been classified with beneficial uses of 1C, 2B, 3A and 4

In addition, Utah DWQ has promulgated state rules that define acceptable water quality in "Standards of Quality for Waters of the State" (Utah Administrative Code R317-2). The applicable standards of focus for this TMDL for East Canyon Creek are noted in Table 2.

Table 2. Water Quality Standards Impaired in East Canyon Creek

Parameter (units are mg/l)	Class 3A Cold Water Fisheries
Total Phosphorus * (mg/l)	.05 (stream) .025 (lake)
Dissolved Oxygen (mg/l)	6.5 (30 day Avg.) 9.5/5.0 (7 day Avg.) 8.0/4.0 (1 day Avg.)

*Total Phosphorus is a pollution indicator that is considered along with other corroborating parameters in order to determine if impairment exists

East Canyon Creek from the reservoir to the headwaters has been listed on Utah's 303d list for total phosphorus and dissolved oxygen. It is the position of DWQ that the dissolved oxygen problem is caused for the most part by excessive nutrients, principally phosphorus, in the water column. This segment of the creek was first listed on the 1992 303d list for nutrients. Dissolved Oxygen was added to the impairments for this segment of the creek on the 1998 303d list.

Water Quality monitoring at several stations along East Canyon Creek and upstream main stem tributaries has been ongoing since 1980. The period of record selected for this TMDL is from January 1, 1993 to September 30, 1999. This period is reflective of more recent water quality for the creek and is concurrent with the most recent growth pattern of this area. The data set is comprised principally of data collected through the Division of Water Quality sampling program. Some of the more recent samples have been collected by the Snyderville Basin Sewer Improvement District and BIO/WEST Inc. (a consultant for DWQ). Except for samples collected in the spring of 1999 by SBSID, all of the laboratory analysis has been conducted by the Utah State Laboratory. Figure A is a map of the watershed that includes sampling stations included in the monitoring program.

Total Phosphorus - Data for total phosphorus at stations 519, 523, 525, and 526 are shown in time series plots in Figures 1-4. While concentrations of total phosphorus below the East Canyon Waste Water Treatment Plant are significantly above the Utah water quality indicator value of 0.05 mg/l, stations above the plant also exhibit values above this indicator. This supports the 303d listing of the creek from the reservoir to the headwaters.

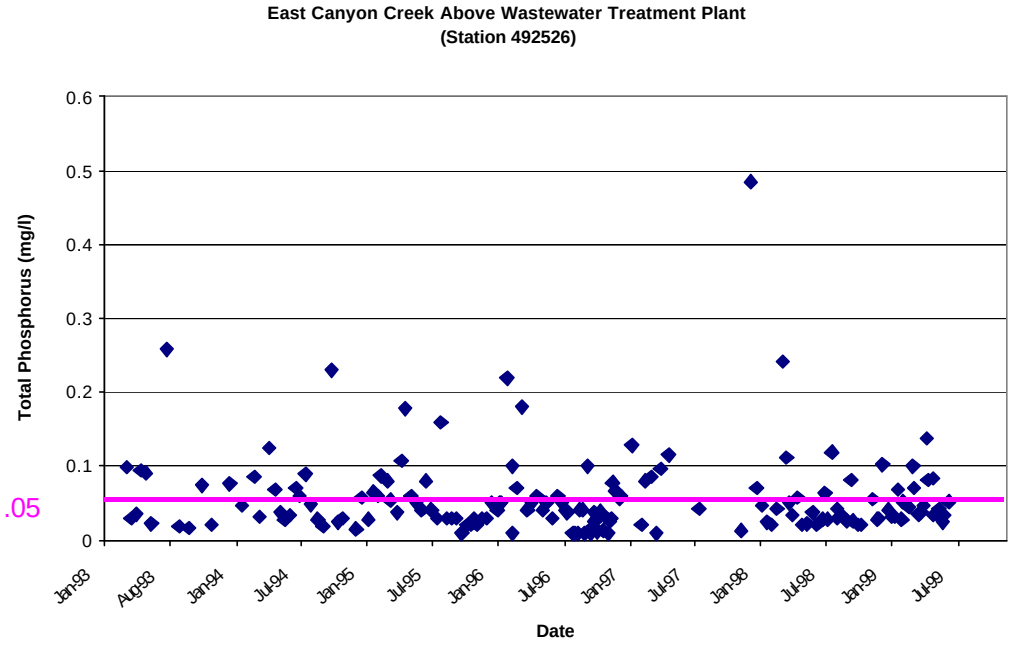

Figure 1. Total Phosphorus Concentration Above WWTP

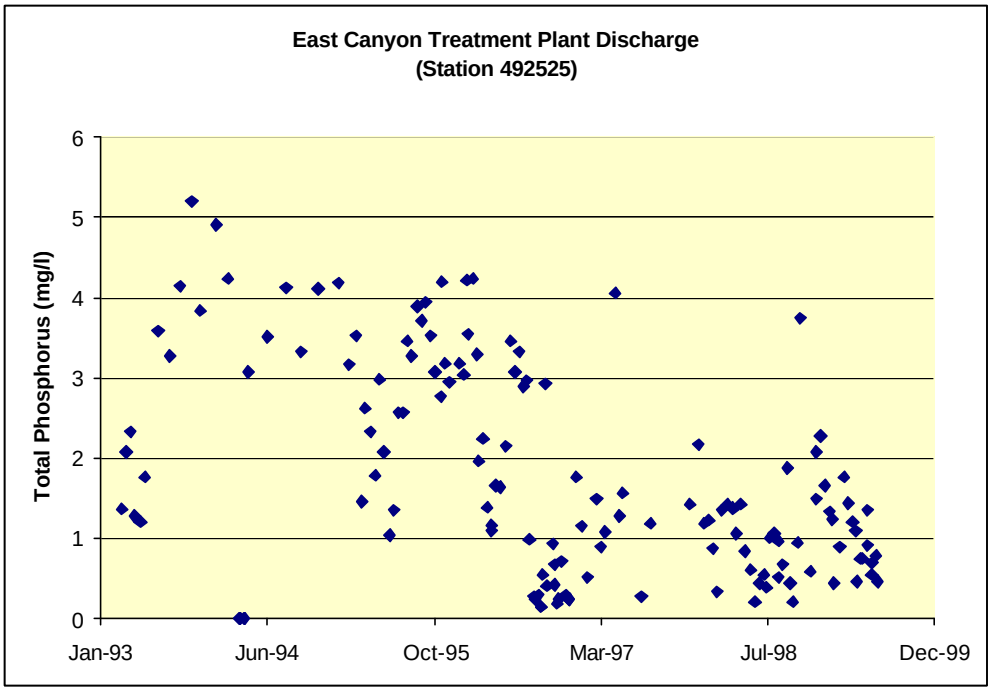

Figure 2. Total Phosphorus Concentrations from WWTP Discharges

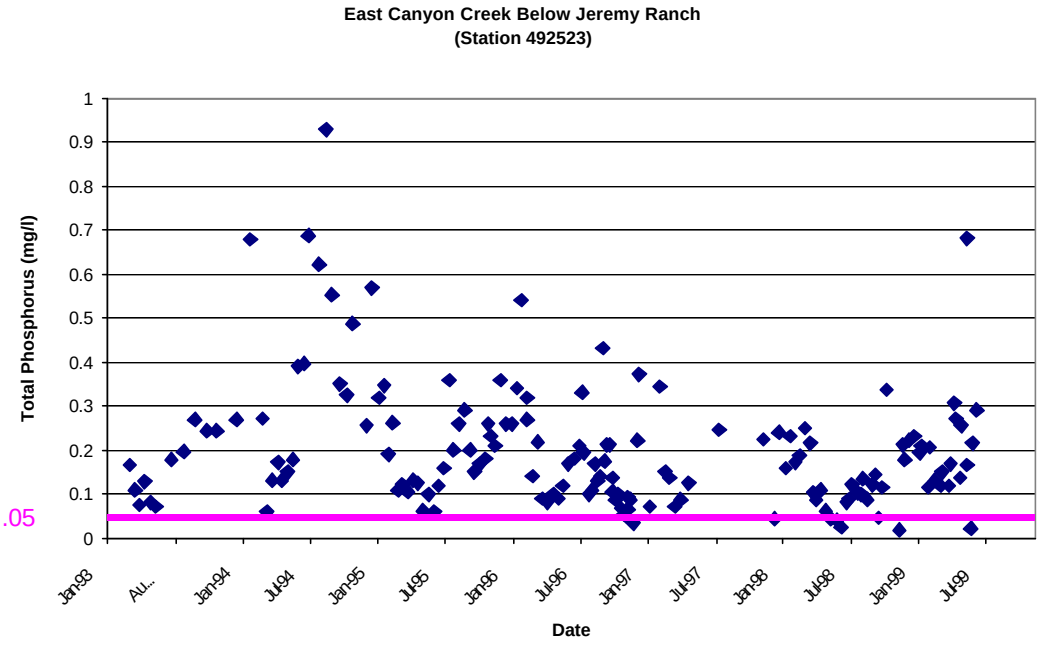

Figure 3. Total Phosphorus Concentration Below WWTP

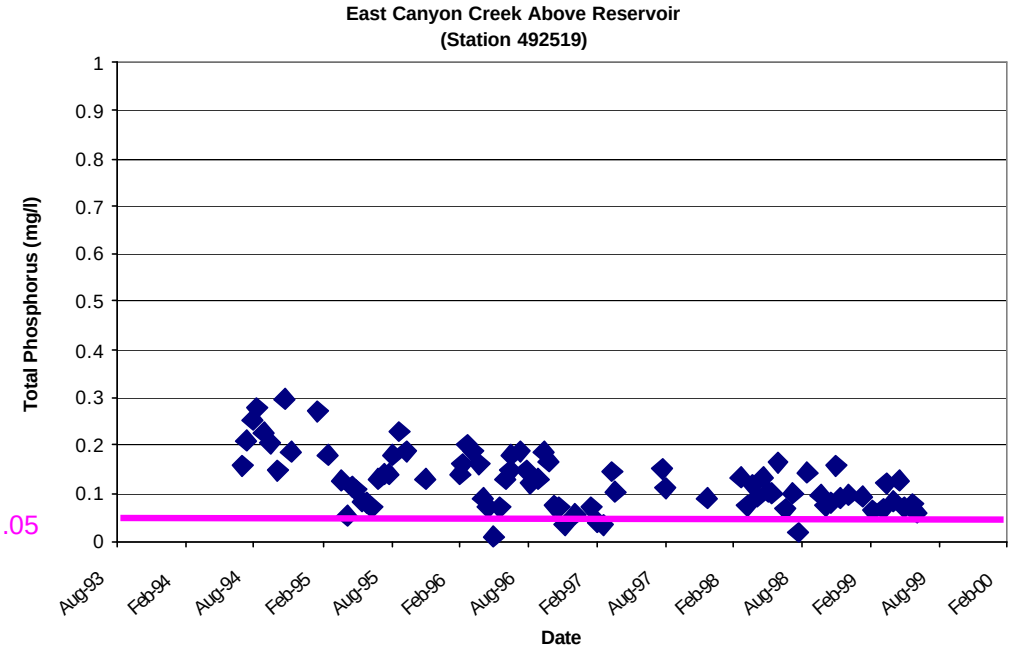

Figure 4. Total Phosphorus Concentrations above East Canyon Reservoir

Dissolved oxygen - Dissolved oxygen data for the period of record is routinely collected during daylight hours and thus does not reflect the diurnal sag believed to be present during baseflow summertime stress periods. A diurnal DO study was undertaken in August of 1996 to assess night time DO levels. Figure 5 shows DO sags over a nine day period in two locations; above the WWTP and at the USGS gaging station near Big Bear Hollow. This lower location is over 2 miles below the plant and should reflect influences from the WWTP, Jeremy Ranch Development & golf course, as well as tributaries such as Toll Creek. This information supports a dissolved oxygen impairment in the creek during the low flow summer season.

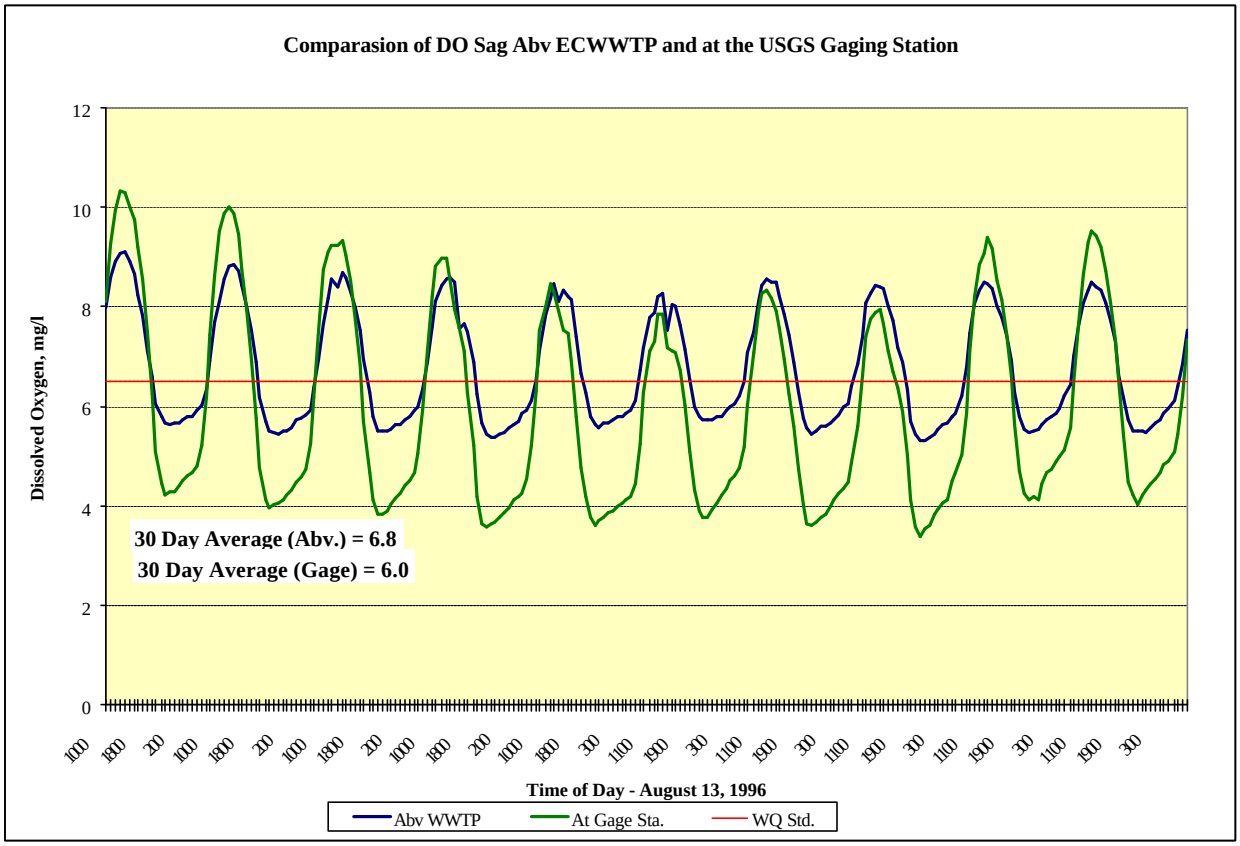

Figure 5. Dissolved Oxygen Sag Above and 3 miles below the East Canyon WWTP, Aug. 1996

The diurnal dissolved oxygen data set will need to be augmented to provide specificity as to the full extent of this impairment along the stream corridor.

Sediment - Although the primary focus of this TMDL is on phosphorus, the available data suggests that the stream channel in many places is impacted by increased deposits of finer grade materials that provides a rooting medium for macrophyte growth and is typically associated with phosphorus that is sorbed onto the sediment. EPA notes that phosphorus is primarily transported in surface runoff with eroded sediments (EPA 1999). Initial storm flow sampling in the upper East Canyon Watershed in the fall of 1999 revealed some stations where concentrations of total phosphorus were

as high as 81 mg/l during one storm event. The corresponding concentrations of dissolved phosphorus were quite low for these samples indicating that the phosphorus was attached to sediment in the sample.

Fish Population - The Utah Division of Wildlife Resources (DWR) has expressed concerns over the fish populations in the creek over the last several years. DWR produced the East Canyon Creek: Aquatic-Riparian Management Plan (1998)which documents a dramatic decline in wild trout populations in Section 3 (E. Cyn. Reservoir to the Summit County border). Measurements from 1988 to 1993 showed a 46% decline in the predominant cutthroat/rainbow trout populations. Similarly, in Section 4 (Summit County border upstream to Interstate 80) the population estimate in 1988 was 199 fish/mile whereas in 1991 the estimate was down to 40 fish/mile. The Division of Wildlife Resources attributes these declines to "decreased flows, low dissolved oxygen levels combined with increased nutrient loading and higher temperatures...".

Declining Stream Flows - As growth and development has increased in the upper watershed summertime low flows have decreased. DWR has noted that flows less than 6 cfs are common during low flow. Officials at the DWR attribute this flow reduction to increased groundwater withdrawals associated with rapid development in the upper watershed and possible trans-basin diversion of urban runoff from Park City out of the East Canyon watershed (DWR 1993). Lower summertime flows have exacerbated the previously documented water quality impairments.

WATER QUALITY TARGETS/ENDPOINTS

The principal endpoints for this TMDL will be total phosphorus and dissolved oxygen. Total phosphorus is a good indicator of nutrient loading for this system and will serve as a readily measurable endpoint. The Utah state indicator value of 0.05 mg/l is not a strict water quality standard but an indicator. Quality Criteria for Water (EPA 1976) suggests that total phosphates as phosphorus not exceed 0.050 mg/l in any stream at the point where it enters any lake or reservoir to prevent biological nuisances and to control accelerated or cultural eutrophication. Since biological activity is determined by a number of variables including temperature, light (or shading), nutrients etc., the use of 0.05 mg/l cannot be universally applied to all systems. Some systems can assimilate higher concentrations of phosphorus and not develop nuisance levels of algae and macrophytes. The reverse is also true. Tetra Tech. completed a report (January 2000) that in part examined this issue and provided a brief review of phosphorus endpoints used for other stream TMDL's. A summary of findings of this report showing endpoints for other stream TMDL's are as follows:

-Truckee River, Nevada .05 mg/l Total Phos.
.075 mg/l Total Nitrogen

-Clark Fork River, Montana 0.02 mg/l Total Phos. upstream from Missoula
0.039 mg/l Total Phos. downstream from Missoula

0.3 mg/l Total Nitrogen

-Tulatin River, Oregon 0.07 mg/l Total Phosphorus (monthly mean May - Oct.)

The report also includes a brief literature review of studies completed on the issue of phosphorus endpoints in stream systems. Based on this report's findings, 0.05 mg/l is a reasonable endpoint that is supported by findings in other locations. However, as will be discussed later in this report, the assimilative capacity of East Canyon Creek to handle nutrient loads should be better understood after some of the implementation measures contained in this TMDL are completed. At that time a more refined endpoint regarding total phosphorus can be adopted for this TMDL.

The measurement of D.O. must occur when worst case conditions exist since a very short period of time where D.O. values fall below state standards can determine the biological health of a system for the remainder of the year. An example of this is if D.O. levels become toxic for fish during the warm low flow period of July and August, fish populations could be diminished or eliminated for the remainder of the year. Diurnal D.O. measurements must be the basis for assessing progress towards restoring the beneficial uses of East Canyon Creek.

The supplemental endpoints that will be used for measuring success in the East Canyon Creek TMDL will be macrophyte and periphyton growth. This appoach is a reasonable indicator of several of the other endpoints including phosphorus, dissolved oxygen, and channel conditions. The BIO/WEST NPS (Olsen & Stamp 2000) study indicated that high macrophyte densities appeared to be associated with poor channel conditions. An endpoint for periphyton needs to be investigated and developed. The endpoint for periphtyon will more accurately represent the relationship between nutrient availability and biological productivity in the stream.

Table 3. East Canyon TMDL Endpoints

East Canyon Creek TMDL Endpoints	
Total Phosphorus	0.05 mg/l (30 day average)
Dissolved Oxygen	6.5 (30 day Avg.) 9.5/5.0 (7 day Avg.) 8.0/4.0 (1 day Avg.)
Macrophyte Growth	25 to 50% density (coverage)
Periphyton	To be developed

SIGNIFICANT SOURCES

The summer low flow season of August and September is the critical season for the creek system. The rationale for this season of interest is detailed further in the "Technical Analysis" section of this document. Accordingly, the creek TMDL focuses on concentrations and biological activity during this period rather than on total annual loads of pollutants of interest. A total annual load assessment which takes into account the entire year is used for the East Canyon Reservoir TMDL.

Total Phosphorus -Table 4 shows the average concentration of total phosphorus for four stations on East Canyon Creek along with average flow estimates to portray the relative proportion of total phosphorus contributions along points of interest on the creek. It should be noted that the flow estimates are derived using average flow data over 1991 through 1996 extrapolated from USGS gage data above Big Bear Hollow. Concentrations of total phosphorus are calculated from DWQ sampling results for 1996 through 1999. The range for calculating average phosphorus values was selected based on the installation of a biological treatment process at the East Canyon WWTP in July 1996. The concentrations of total phosphorus in the effluent from the East Canyon WWTP were significantly reduced following installation of this process. Accordingly, the most accurate way to evaluate the creek system is after July 1996.

The concentration of total phosphorus at station 526 above the WWTP was evaluated for the period 1993 through 1995. Concentrations of total phosphorus were slightly higher during this interval at 0.05 mg/l compared to 1996 through 1999 time period. The data in Table 4 indicates that the treatment plant provides the largest portion of total phosphorus to the system during the low flow season. It should be noted that this assessment does not include an accurate accounting of the impact and resulting phosphorus contributions from rainfall events that can occur during this time period.

Table 4. Average Total Phosphorus Concentrations and flows Aug. - Sept., 1996-1999

Station	526 Above WWTP	525 East Cyn. WWTP	523 Below Jeremy Ranch	519 Above East Cyn. Res.
Average Total Phos. (mg/l)	0.04	0.97	0.22	0.12
Standard Deviation	0.02	0.85	0.13	0.04
Number of Samples	18	18	18	12
Maximum Value Observed	0.12	2.96	0.52	0.19
Minimum Value Observed	0.02	0.14	0.09	0.02

Average Flow Estimate (cfs)	8	2.6	9	17.5

Based on storm event sampling conducted by BIO/WEST in the fall of 1999, significant loads from rainfall events are likely. This suggests that the contribution of total phosphorus loads from nonpoint sources could be more significant than the current data set indicates. Future sampling will need to address this aspect, however none of the conclusions of this TMDL would be significantly altered by this factor for the stream TMDL. Both nonpoint sources and point sources must be addressed by this TMDL to restore beneficial uses in the creek. Assuming future storm event sampling demonstrates significant loads occur during storms, the BMP's included in the implementation portion of this TMDL would not likely be different. A more detailed discussion of nonpoint sources is contained in the BIO/WEST NPS report.

Dissolved Oxygen - The diurnal data set for dissolved oxygen (D.O.) is limited, however analysis above the East Canyon Treatment Plant and at a point over two miles below the plant during August 1996 does show periods of several hours each day where dissolved oxygen levels fall below state standards. This phenomenon would either stress or prove fatal to biota sensitive to dissolved oxygen such as salmonid fish and their food chain. Figure 5 illustrates the D.O sag observed at these two sites. As noted previously in this document, the D.O. data set will need to be augmented with multiple sampling sites to ascertain the sources of D.O. sag.

TECHNICAL ANALYSIS

The impairments identified with East Canyon Creek are primarily expressed in excessive biological activity. Specifically, periphyton and macrophyte growth during the optimal growing season results in dissolved oxygen levels falling below state standards during the night when these organisms are actually consuming oxygen rather than producing it as occurs during daytime photosynthetic activity. The low dissolved oxygen levels impair other biological communities such as fish and benthic macro-invertebrates along with reducing habitat and inhibiting movement. The relationship between excessive biological activity and levels of nutrients available is documented in the literature. In this TMDL, one of the primary focuses is on total phosphorus as a source component to the indications of excessive biological activity. However, DWQ reserves the right to further refine this analysis in the future if the need arises. This may involve additional linkage analysis to identify any other parameters that may be contributing to the impairments identified in this TMDL.

Seasonality - The impairments observed in East Canyon Creek are exhibited seasonally, occurring when day length affords sufficient light inputs, when temperatures in the stream are at their maximum, and when flows are at their minimums. Intuitively, this would be in the summer months. Analysis of temperature data, typical flows, and day length shows that August and September are the

months when optimal conditions for excessive biological activity occur, specifically, periphyton and macrophyte growth. At other times of the year day length and temperature constraints do not allow for as much biological growth. Accordingly, this TMDL analysis will focus on August and September as the critical season with the understanding that if impairments are addressed in the critical season, other parts of the year should not present impairment problems as far as the creek is concerned.

Average August concentrations of total phosphorus are shown in Table 4 for monitoring stations 526, 525, 523 and 519.

The station below Jeremy Ranch is sufficiently far below the discharge of the WWTP that good mixing is achieved by the time flows reach this station. It is notable that the average concentration of total phosphorus from the WWTP was substantially reduced through the implementation of biological treatment that was implemented in July 1996. It is also important to note that East Canyon Creek runs through the Jeremy Ranch Golf Course which lies between station 525 and station 523 below the WWTP. Thus impacts from the golf course and tributaries such as Toll Creek would be reflected in samples from station 523.

Growth - The upper portion of the East Canyon Watershed has experienced explosive growth over the last 5 to 10 years. Projections for growth compiled by the Mountainlands Association of Governments show projected population growth from the years 2000 to 2020 for the Park City area of 52% (6,750 to 10,246 residents). The Snyderville Basin area outside Park City boundaries is not specifically noted in the growth projections available. However, the same projections show un-incorporated portions of Summit County growing 103% between the years 2000 to 2020. From the Jeremy Ranch area downstream to the East Canyon Reservoir (over half of the watershed) little growth is presently occurring. The land use information compiled in the NPS study performed by BIO/WEST shows virtually all of the lower portion of the watershed as forested and semi-active agriculture. Most of the lower watershed is contained in Morgan County. Growth projections for Morgan County compiled by Wasatch Front Regional Council between 2000 and 2020 show projections of around 50%. However, the majority of this growth will most likely occur below the East Canyon Reservoir, indicating that the growth rate of the lower half of the watershed between the Snyderville Basin and the reservoir will be quite modest. Using a population weighted average for Park City (52% growth rate) and the Snyderville Basin (103% growth rate) and not factoring in the much smaller growth rates expected for the lower watershed, a growth rate of 80% will be used for purposes of this TMDL. This growth rate is expected to be somewhat overestimated for the overall watershed and is consistent with use of conservative assumptions to allow for a margin of safety in TMDL calculations.

The estimation of overall growth incorporates the assumption that future land disturbing activities will be in proportion with population growth. Several high profile projects are either under construction or are planned for construction over the next several years. These include a proposed

pipeline project to bring water back up into the Snyderville Basin from East Canyon Reservoir, 2002 Olympics related venues, road construction projects, as well as recreational sites such as golf courses. Careful focus will need to given to these higher profile projects to assure that impacts to water quality is minimal. Coordination with the Snyderville Basin Planning Commission to assure that new projects include comprehensive stormwater controls for both the construction and operation phases must be undertaken to assure that the cumulative impacts of these projects does not erode the assumptions used for growth or the margin of safety set aside for uncertainty. In addition, DWQ will need to utilize all provisions of the UPDES Stormwater program to assure projects implement needed controls and design to minimize water quality impacts.

East Canyon WWTP Growth - The Snyderville Basin Sewer Improvement District East Canyon Wastewater Treatment Plant annual discharges are presently just under 2 MGD average annual flow. The final build-out of the plant has not been officially determined. The current expansion design for the plant is for 4 MGD with ultimate build out at 8 MGD. Projected growth of the plant indicates the 8 MGD capacity could be reached close to the year 2020. Growth of plant discharges from the current 2 MGD capacity to 8 MGD capacity would be a growth rate in excess of 100% which is higher than population growth projections for this area. The actual flows that are processed by the plant are controlled by several factors not directly tied to population growth. The capacity of the plant is affected by the number of nonresident recreational visitors to this area. There are two plants operated by SBSID for this area. The flows from portions of the upper watershed can be directed to either plant. Water rights restrictions dealing with transfer of waters to another basin may also determine the ultimate build out for the WWTP. Further, August flows during the critical season for this TMDL will range from about 70 to 80% of plant capacity.

Simple Mixing Model - A simple flow weighted mixing calculation was used to evaluate the critical season conditions and establish what the effluent limit for the WWTP would need to be to produce an in stream value of Total Phosphorus below the plant discharge after mixing under a variety of scenarios. The inputs used are shown in the following table.

Table 6. Mixing Calculation Inputs and Variables

Model Inputs/Outputs	Concentration of Total Phos.	Flow
Station 526 (upstream of WWTP)	Average Aug. concentration varied from 0.03 to 0.06 mg/l	3.5 cfs (2.26 MGD) or 8 cfs (5.2 MGD)
East Canyon WWTP Discharge	Derived from model	Varied from 1 to 9 MGD
Creek downstream of WWTP after mixing	Fixed at 0.05 mg/l or 0.07 mg/l	Sum of upstream flow and WWTP discharge

The rationale for average August concentration of upstream phosphorus values evaluated are:

0.03 mg/l is the current value (0.04 mg/l) reduced by 25% to reflect implementation of BMPs to address nonpoint source inputs.

0.04 mg/l is the current value of upstream total phosphorus concentration assuming no action is taken.

0.05 mg/l reflects the current concentration with a 25% reduction of nonpoint sources and an 80% growth factor.

0.06 mg/l is derived from the 0.05 conditions but with a 100% growth factor instead of 80%.

Two upstream flow conditions were analyzed. The **3.5 cfs** value is from the 7Q10 flow rate used in the latest DWQ waste load analysis for the East Canyon WWTP UPDES permit. This value reflects a worst case scenario assuming toxic parameters are discharged into the creek. The **8** cfs value reflects the average low flow from USGS gage data for 1991 through 1996 for August through September.

The two endpoints evaluated of 0.05 and 0.07 mg/l were selected to reflect the current DWQ water quality advisory value for total phosphorus (0.05 mg/l) and the higher value (0.07 mg/l) to reflect an optimistic perspective that stream enhancements with shading, stream bank stabilization, decreased width to depth ratios could increase the creek assimilative capacity to handle nutrient inputs.

The following simple diagram illustrates the conceptual set up of the model. Essentially, if the outcomes of the concentration for the stream following mixing are fixed at the endpoint selected for total phosphorus and the upstream flow and concentration are known then the concentration of the effluent required to achieve the downstream endpoints is a simple mathematical calculation.

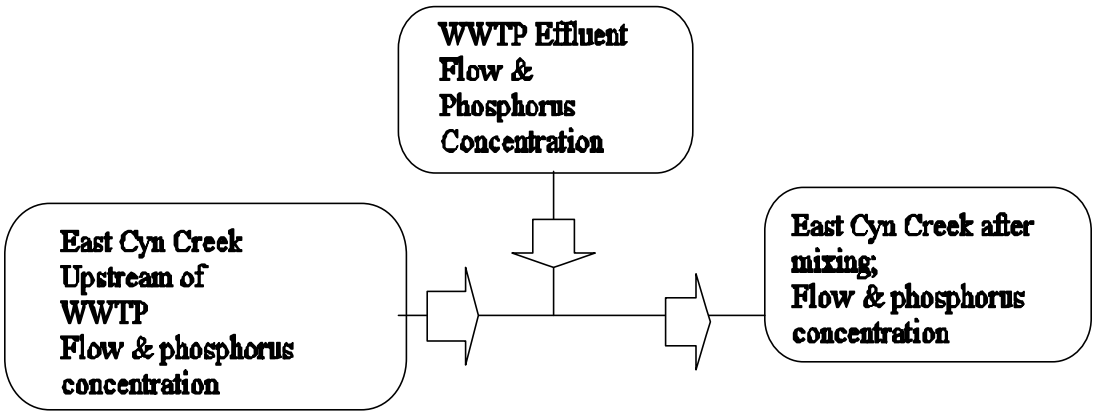

Figure 7. Conceptual Simple Flow Weighted Calculation for East Canyon Creek

To illustrate this approach, the calculations using the following inputs were completed.

Upstream flow	3.5 cfs
Upstream total phosphorus	0.03 mg/l
WWTP flow	Varied from 1 to 9 MGD
Downstream flow	3.5 cfs + WWTP flow
Downstream total phosphorus	0.05 mg/l

A plot of the model outputs for these conditions (Figure 8) shows the result of this scenario. For any given WWTP output (located on the horizontal axis), the required concentration of total phosphorus in the WWTP effluent can be determined from the curve on the graph. For instance, at a WWTP flow rate of 2 MGD, the concentration of total phosphorus in the WWTP effluent would need to be 0.072 mg/l to achieve the downstream 0.05 mg/l phosphorus outcome. The arrows on the graph show this example.

Similar plots of the outcome from each of the scenarios is shown in figures 9-12 . These plots show multiple curves for each upstream concentrations of total phosphorus under the scenarios chosen for this analysis.

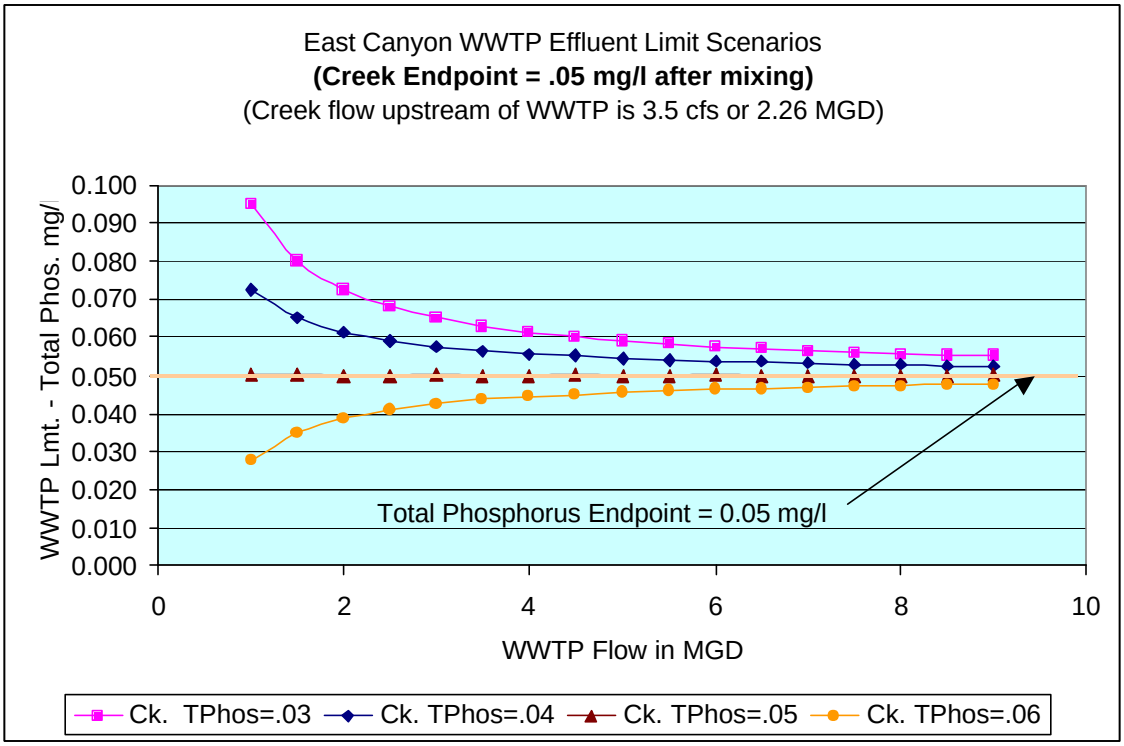

Figure 9. Upstream flow is 3.5 cfs; Downstream total phos. after mixing is 0.05 mg/l

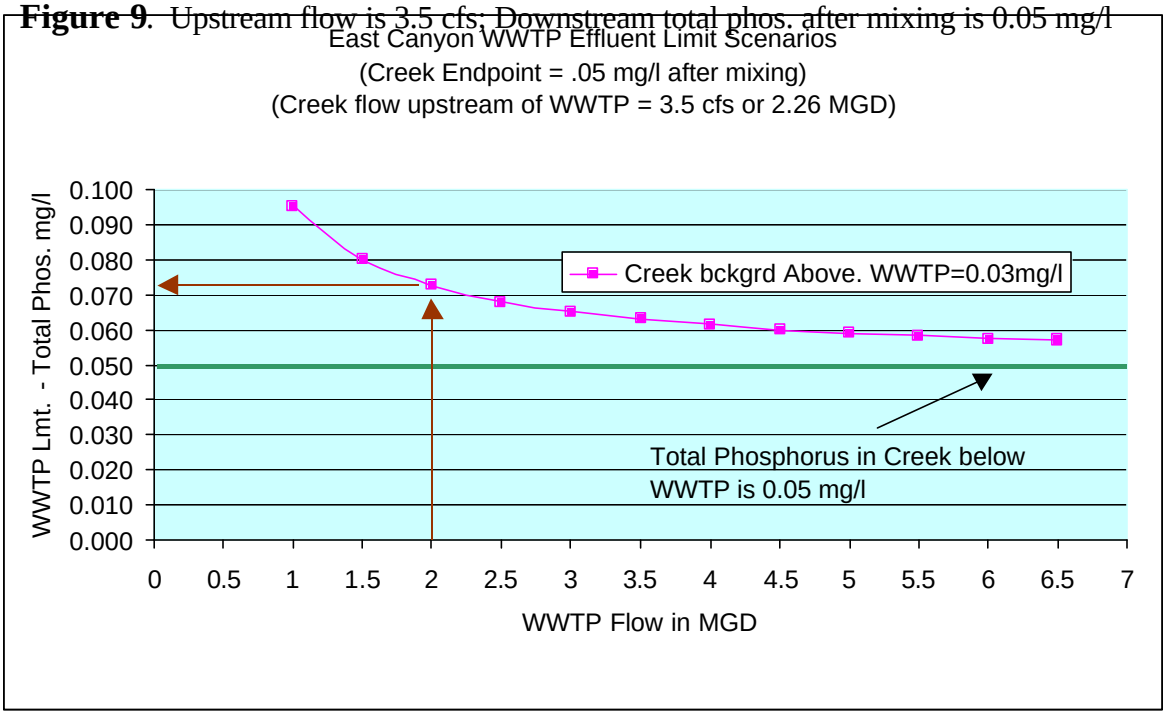

Figure 8. Plot of WWTP flows and required WWTP phosphorus concentrations to meet a 0.05 mg/l total phosphorus concentration in the creek after mixing.

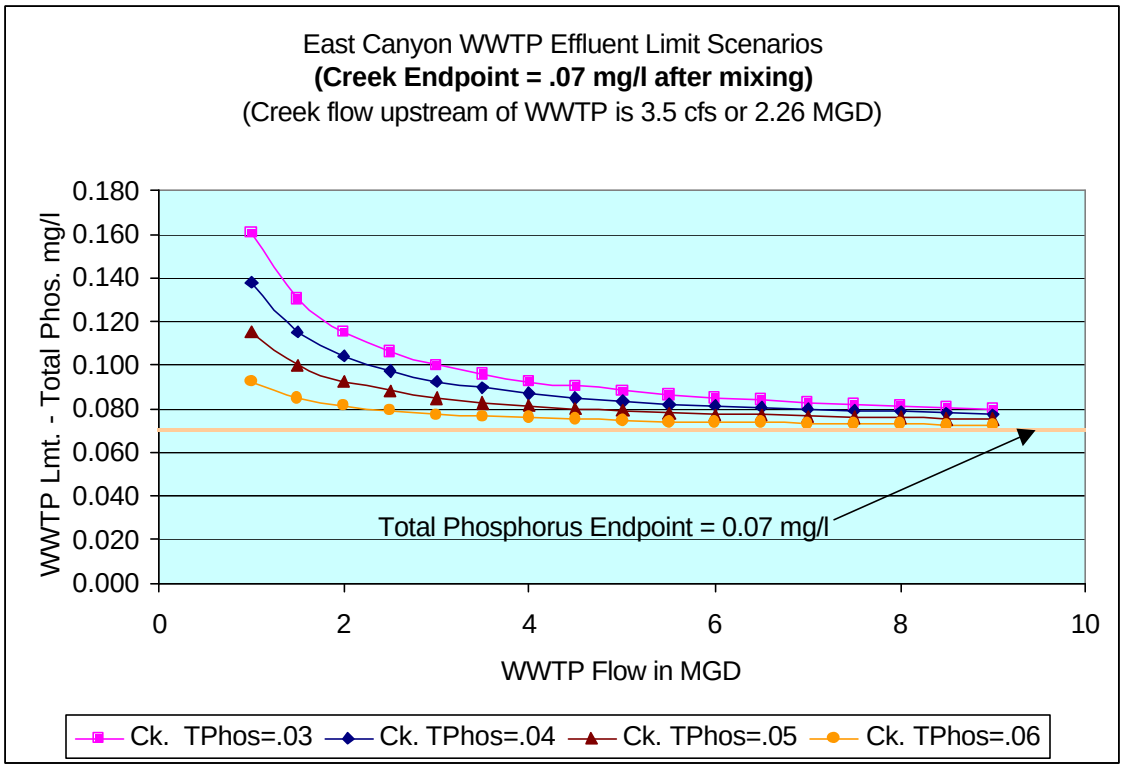

Figure 11. Upstream flow is 3.5 cfs; Downstream total phos. after mixing is 0.07 mg/l

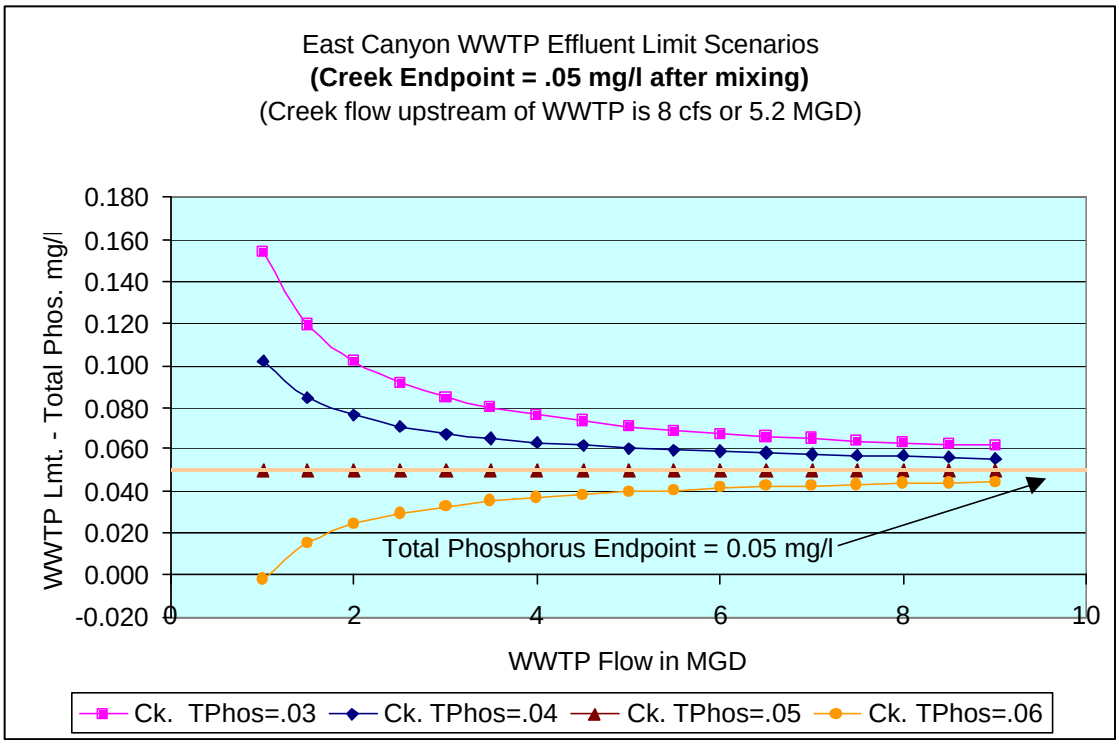

Figure 10 Upstream flow is 8 cfs; Downstream total phos. after mixing is 0.05 mg/l

Figures 11 and 12 show the effect on the phosphorus limit curves if the assimilative capacity of the creek could be shifted to handle 0.07 mg/l of phosphorus with stream channel enhancements such as stabilizing eroding banks, establishment of woody species such as willows to provide shading, and narrowing and deepening the channel profile to minimize summer

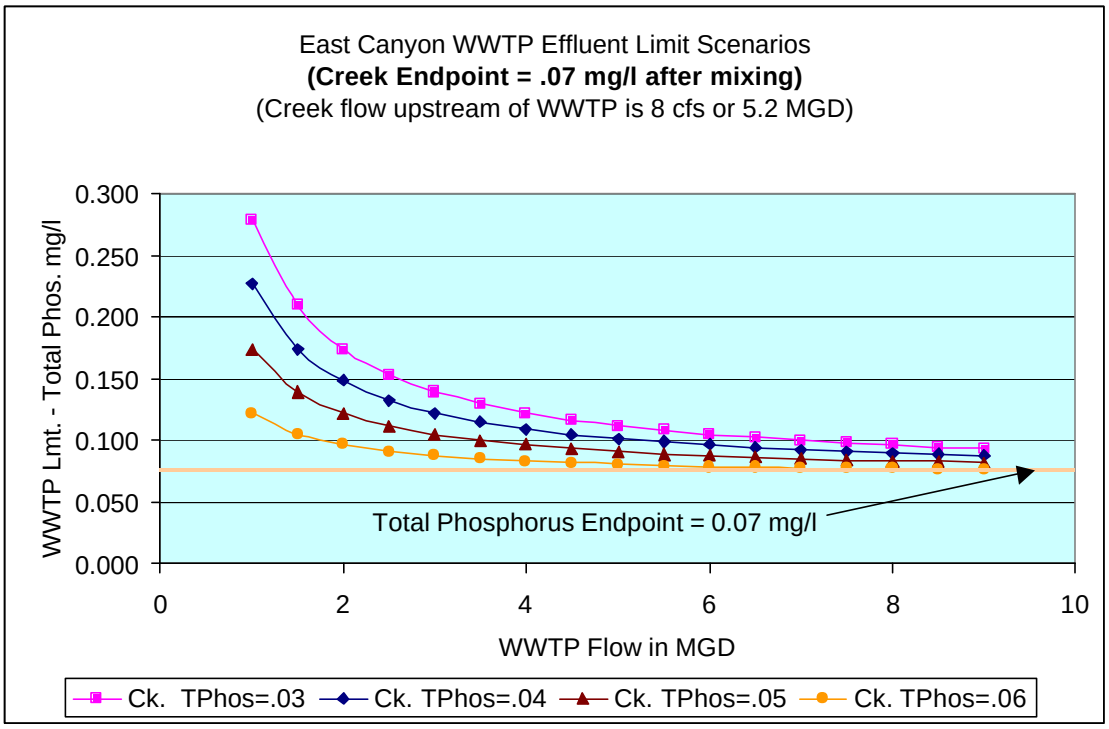

Figure 12 Upstream flow is 8 cfs; Downstream total phos. after mixing is 0.07 mg/l.

heating potential.

This analysis shows there are five variables that can be addressed to achieve the total phosphorus endpoints for this TMDL:

1. *Reduction of Effluent Concentration from the East Canyon WWTP* - The effluent concentration for the East Canyon WWTP needs to be lowered to levels as indicated on the preceding plots.

2. *Reduction of Nonpoint Sources of Phosphorus* - The upstream concentration of total phosphorus needs to be reduced as much as possible for two reasons. The stream above the WWTP is impaired in some reaches and the endpoints for total phosphorus and dissolved oxygen must be attained. Additionally, the upstream concentration of total phosphorus should be minimized to allow the treatment plant opportunity to meet what will be a stringent effluent limit given the best availability technology.

3. *Reduction of East Canyon WWTP Flows During Critical Season* - Means to reduce the discharge flows of the treatment plant during the critical summer season **if the stream flow is not diminished** need to be explored. This could be accomplished by land applying treatment plant effluent on golf courses or parks and allowing the water normally used to irrigate these areas to flow the creek as replacement flow.

4. *Stream Stabilization and Enhancements* - Measures to shift the assimilative capacity of the creek to a higher level would allow for a higher endpoint of total phosphorus concentration in the creek. These include stabilizing eroding banks, establishment of woody species such as willows to provide shading, and narrowing and deepening the channel profile to minimize summer heating potential.

5. *Augmentation of Creek Flow During Critical Season* - Any measures that would increase the summer low flows in the creek above the WWTP without increasing the upstream total phosphorus concentration would improve downstream concentrations of phosphorus due to increased dilution of WWTP flows.

TOTAL MAXIMUM DAILY LOAD

The approach adopted in this TMDL is to have the East Canyon Treatment WWTP incorporate best available technology for removal of phosphorus as soon as possible. This process will probably take around three years for design and construction and another year for optimization of the process. Given the uncertainty of the concentration of total phosphorus that this process will yield after plant optimization, a specific permit limit for the East Canyon WWTP will not be set at this time, but will be set following construction and optimization of BAT and based on achievable phosphorus levels. Whatever difference remains between the achievable WWTP total phosphorus concentration and the necessary endpoint to restore beneficial use in the stream will be addressed by the other variables identified in the technical analysis (nonpoint source reductions of phosphorus loads, reduction of

plant discharges during the critical season, stream enhancements, augmentation of low flows during the critical season). Stakeholders in the watershed will want to evaluate each of the variables noted and the associated costs and constraints for each to determine what actions will need to be taken to assure the beneficial uses of the creek are restored.

Much of the focus of this TMDL is on the East Canyon WWTP, however, the impact of nonpoint sources to the impairment of the creek, particularly above the WWTP must be addressed in order to assure restoration of beneficial uses of the creek. Given the growth that is anticipated in the upper watershed, and the capability of the technology to be implemented at the WWTP, the stream above the wastewater treatment plant must at a minimum maintain a total phosphorus level during the critical low flow season of 0.04 mg/l. Accordingly, one of the targets of this TMDL will be an in stream concentration of total phosphorus above the WWTP of 0.04 mg/l. Hopefully with effective implementation of BMP's to address nonpoint sources of phosphorus, a value lower than 0.04 mg/l can be achieved.

Table 7. TMDL allocation with various WWTP flows and variations of NPS BMP effectiveness scenarios.

		Load Allocation		Wasteload Allocation				TMDL Allocation
Upstream Flow (cfs)	Upstream T. Phos. (mg/l)	Upstream NPS lbs./day	WWTP Flow (mgd)	WWTP T. Phos. (mg/l)	WWTP Load lbs./day	Down stream Flow (cfs)	Down stream T. Phos. (mg/l)	Down stream lbs./day
8	0.040	1.73	1.7	0.081	1.13	10.6	0.05	2.86
8	0.030	1.29	1.7	0.112	1.56	10.6	0.05	2.86
8	0.024	1.04	1.7	0.130	1.82	10.6	0.05	2.86
8	0.040	1.73	4	0.063	2.10	14.2	0.05	3.83
8	0.030	1.29	4	0.076	2.53	14.2	0.05	3.83
8	0.024	1.04	4	0.084	2.79	14.2	0.05	3.83
8	0.040	1.73	8	0.056	3.77	20.4	0.05	5.50
8	0.030	1.29	8	0.063	4.20	20.4	0.05	5.50
8	0.024	1.04	8	0.067	4.46	20.4	0.05	5.50

Table 7 depicts TMDL allocations for some of the most likely scenarios that will occur over the next several years. WWTP Flows are currently at 1.7 MGD(2.6 cfs), but with the planned expansions to the WWTP will grow to 4 mgd (6.2 cfs), and possibly to 8 MGD (12.4 cfs). The stream above the WWTP is impaired and will need to be addressed through the application of BMP's as outlined in the Implementation section of this TMDL. The effectiveness of BMP's on nonpoint source controls is estimated at three levels: no effect (0.04 mg/l), 25% effective (0.03

mg/l), and 40% effective (0.024 mg/l). Table 7 illustrates that the upstream concentrations of total phosphorus must be controlled in spite of significant growth and at worst must not increase over current levels. The concentration of total phosphorus that will be allowed from the WWTP will need to be in the range of 0.05 to 0.08 mg/l to assure a downstream concentration after mixing no greater than 0.05 mg/l. All of these values are subject to change following further analysis, sampling, assessment of the effectiveness of BMP application, and determination of the actual assimilative capacity of the creek.

Dissolved oxygen shall achieve the endpoint specified per Utah State Water Quality Standards. The stream shall be measured in August using diurnal measurements with the minimum D.O. measured equal to or above the standard.

MARGIN OF SAFETY

The Margin of Safety used in this TMDL is achieved through the incorporation of conservative assumptions in the calculations and approaches utilized and in the use of multiple endpoints. These include the following:

1. This TMDL incorporates multiple endpoints including: Total Phosphorus, Dissolved Oxygen, Macrophytes, & Periphyton. Use of multiple endpoints provides additional assurance that the beneficial uses that are impaired will be restored.

2. Use of conservative values of 25% to 40% to reflect NPS load reductions from the implementation of Best Management Practices to reduce nonpoint source pollution sources. The range of values from the BIO/WEST NPS report were from 40% to 90% reductions of total phosphorus for all land uses except active agriculture. Impacts of active agriculture are diminishing with land use changes in the watershed from agriculture to more development and recreational uses. The NPS report shows active agriculture comprises 2% of the land use in the watershed. Effectiveness of agriculture land use BMP's for reduction of NPS total phosphorus ranged from 10 to 70% in the BIO/WEST report.

3. An ongoing monitoring program will be implemented to assure that the specified endpoints are being achieved. If monitoring reveals that the TMDL values selected in this document are not being achieved, this TMDL will be revisited and revised limits derived to assure endpoints will be achieved.

IMPLEMENTATION MEASURES

The following implementation measures need to be undertaken to successfully achieve the endpoints identified in this TMDL:

1. *Treatment Plant BAT Upgrade* - The SBSID East Canyon Wastewater Treatment Plant must expeditiously plan, construct and optimize best available technology to remove

phosphorus from the plant effluent. This will include chemical phosphorus removal coupled with biological treatment.

2. *Local Storm Water Programs* - Local Storm Water Programs need to be implemented to minimize phosphorus and sediment contributions to East Canyon Creek. Storm Water Controls for storm water runoff, particularly from construction areas must be implemented to minimize sediment and associated phosphorus. Additionally, the use of stormwater detention ponds as outlined in the Clean Lakes Report (Judd 1999) should be included in this effort. This program should be a locally driven and implemented. Utah DEQ Division of Water Quality can require Summit County and Park City to develop a Storm Water Program that includes:

> -formal storm water permit program that will review storm water plans and facilities, and formal enforcement in accordance with the UPDES Storm Water Program requirements. These programs must incorporate strict adherence to best management practices, at least weekly inspections of disturbed construction sites and vigorous enforcement actions for those sites that either violate the terms of their permit or fail to properly obtain a storm water permit.

3. *Ski Hill Watershed Management Plans* - The Park City Ski Hill and the Canyons Ski Hill will be required to submit formal storm water control plans (Watershed Management Plans) to minimize sediment and related phosphorus losses from their respective properties. These plans will need to assess the phosphorus loading resulting from their operations including snow-making and use of fertilizers to stabilize high traffic areas such as chair lift exits etc.

4. *Stream Channel Restoration* - The BIO/WEST NPS Report identified several stream channel reaches that are degraded and are contributing additional amounts of sediment and total phosphorus. A locally led effort to work with landowners is needed to implement stream channel restoration and rehabilitation measures. This should include measures to restore natural shading along with narrowing & deepening the channel to promote cooler water temperatures as well as reduce light inputs needed for macrophyte growth. This measure should include the following aspects:

> -fencing the stream channel and riparian areas from livestock
> -stream channel reconstruction to achieve appropriate channel and floodplain dimensions
> -stabilizing eroding streambanks
> -removal of fine materials from the streambed
> -re-establishing woody vegetation along streambanks to provide bank shading

5. *Nutrient Management Plans* - All golf courses and other large areas with intensive turf management such as public parks will need to develop management plans to reduce phosphorus loads to the watershed. Aspects of these plans should include:

-Types of fertilizers used
-application rates and timing
-restrictions near stream channels and riparian & wetlands areas such as buffer strips and "no mow" zones.
-irrigation rates including water quality analysis of return flows

Local phosphate detergent bans should also be implemented by local entities.

6. *Road Drainage Controls* - The dirt road that runs from Jeremy Ranch down East Canyon until it intersects with State Route 65 appears to be significant source of sediment for the creek below the Jeremy Ranch Golf Course. The sediment provides additional phosphorus and sediments in the channel that allow macrophyte rooting habitat. The drainage controls for this road need to either be upgraded to minimize sediment contributions or the road should be paved to address this sediment problem.

7. *Nutrient Loading Study* - The phosphorus loads estimated for the tributary that drains the Silver Creek Estates area suggest that abnormally high loads are coming from this area. Coincidentally, this area is not sewered but is served by individual septic systems. A study needs to be conducted to ascertain what the source of these loads are and what implementation measures need to be undertaken to minimize phosphorus loading from this area.

8. *Ongoing Water Monitoring Program* - An ongoing water monitoring program needs to be conducted to further refine loading sources and to monitor stream responses to the preceding implementation actions.

The East Canyon Watershed is considered a high priority watershed for receipt of Section 319 nonpoint source program funding purposes. It is the Division's intent to facilitate and support project proposals for 319 funding for implementation projects in concert with this TMDL.

PUBLIC PARTICIPATION

The public participation process for this TMDL was addressed through the use of a series of public meetings and a local watershed committee. The East Canyon Water Quality Steering Committee has been in operation for several years prior to this TMDL. The committee is comprised of individuals that represent a broad based and diverse cross section of the interested stake holders in the watershed. All of the committee meetings are open to the public. The focus of the most recent meetings held on January 5 and February 9, 2000 was the nonpoint source study completed by BIO/WEST and the draft TMDL.

In addition the Division of Water Quality in coordination with the East Canyon Water Quality Steering Committee held public meetings to provide information and education on the TMDL process and to take comment on the draft TMDL. The first set of meetings were held on the evenings of December 7 and 14, 1999 in the Park City area and in Morgan Utah respectively. The

primary purpose of these meetings was to advise the public that a TMDL was being compiled, the issues to be considered and addressed, and the time frames for compiling the TMDL. Attendance at these two meetings was good with over 75 people at the Park City meeting and over 28 at the Morgan meeting.

A second public meeting was held on February 28, 2000 in the Park City area to discuss and take comment on the draft TMDL. Attendance at this meeting was over 60 people.

Each of the public meetings were advertised in local news media. A letter of invitation and Information Update was also sent to over 80 interested citizens advising them of the meetings.

A formal 30 day public comment period was held (February 18 through March 19) to allow input and comment on the draft TMDL.

In addition the draft TMDL document was available on the Division of Water Quality's web site for review during the 30 day public comment period.

Attached to both of the TMDL's for the East Canyon Watershed are the comments and a summary of responsiveness for those comments received during the comment period on the draft TMDL's. The Division received 11 comment letters during the 30 day comment period.

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